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(77) [JUDGEMENT CLAIM] No data relevant

(54)[THE TITLE OF THE INVENTION]
MICROCELLULAR FOAMING GAS SUPPLY APPARATUS

[ABSTRACT]

As the foregoing microcellular foaming apparatus has the problem of disableness in an injection process where super critical fluid should be supplied intermittently for the super critical fluid injection is not controllable accurately. The invention relates to an injection screw which is located in a barrel and injects application materials and a microcellular foaming apparatus including a gas supply means supplying a super critical fluid to the inside of said barrel and generating a microcellular bubble in the application materials; said gas supply means is characterized as including a reservoir tank storing the fluid, a compressor compressing the fluid from said reservoir tank, a pressure tank where the fluid compressed in said compressor is stored temporarily, the first valve located in a pipe between said compressor and the pressure tank, a high pressure tank where the fluid supplied from said pressure tank is stored temporarily and the fluid stored by heating is transformed into the super critical fluid, the second valve located in a pipe between said pressure tank and the high pressure tank, a heater located around said high pressure tank, a heater controller controlling said heater with sensing the temperature of said high pressure tank, the third valve located in a supply pipe supplying the super critical fluid of said high pressure tank into the inside of said barrel, a controller part controlling the movement of each valve and said compressor with sensing signals of said controller part of the molding apparatus and the pressure of each tank.

[REPRESENTATIVE DRAWINGS]]
Figure 4

[SPECIFICATION]
[BRIEF DESCRIPTION OF THE DRAWINGS]

Figure 1 is an arrangement view showing the foregoing microcellular extrusion molding apparatus;
Figure 2 is an arrangement view showing the foregoing microcellular injection molding apparatus;
Figure 3a is a pressure-specific volume diagram;
Figure 3b is a temperature-specific entropy diagram;
Figure 4 is an arrangement view showing a microcellular foaming gas supply apparatus according to the invention.

[AN EXPLANATION FOR THE MARKS OF THE DRAWINGS]

50 : barrel	51 : injection screw
52 : heater	53 : hopper
54 : reservoir tank	55 : compressor
56 : pressure tank	57 : high pressure tank
58 : heater	59 : heater controller
60a,60b,60c,60d : valve	61 : molding apparatus controller part
62 : controller part	63,56',57' : pressure sensor
57" : temperature sensor	70 : high molecular material

[DETAILED DESCRIPTION OF THE INVENTION]
[THE OBJECT OF THE INVENTION]
[FIELD AND BACKGROUND OF THE INVENTION]

The invention relates to a microcellular foaming technology generating micro bubbles in the high molecular material for reduction of the amount of plastic used and in particular a microcellular foaming gas supply apparatus controllable of the supply into the cylinder of the molding apparatus according to the signals of the molding apparatus after transforming compressed gas into a super critical fluid.

Plastic is one of the most useful wares among the inventions man has invented. Plastic is used in the necessary shape of goods molded from various high molecular materials, Recently to reduce the amount of plastic used and the weight of the plastic wares, microcellular foaming technology of molding wares with generating bubbles of the extremely micro scale, in particular 0.1～ 30 μm was developed. As the microcellular foaming technology reduces the weight of the wares and the cost of the materials, the frequency of the use is gradually increasing.

The process of generating the microcellular bubbles is based on the principle that thermochemical instability is brought about when lowering pressure and increasing temperature after injecting into high molecular material on microcellular state and saturating gas like carbon dioxide(CO_2) so bubbles are generated when carbon dioxide contained in high molecular material becomes a core and expands, and this process has refrigerating process in addition so as to restrain the growth of the bubbles. With applying this principle to continuous process microcellular foaming technology by extruding process was developed.

As shown in figure 1, the view of the foregoing microcellular extrusion molding apparatus, the microcellular extrusion molding apparatus is composed of a

extrusion screw(14) located in the extrusion barrel(11), a hopper(13) for supplying high molecular material into the barrel(11), a heater(12) located around said barrel(11) and melting the high molecular material in the barrel(11), the reservoir tank(15) storing fluid, a compressor(16) supplying the fluid supplied from the reservoir tank(15) into said barrel(11) with compressing on super critical state, and a compressor mold(17) extruding the high molecular material saturated with the super critical fluid.

The foregoing microcellular extrusion molding apparatus composed as such generates micro bubbles in the wares molded by extruding the melted high molecular material containing the super critical fluid.

When the high molecular material is supplied into the compressor barrel(11) heated by the heater(12) through the hopper(13), the high molecular material is melted with mix milling by the extrusion screw(14). Then, the fluid(CO_2) is supplied into the barrel(11) from the reservoir tank(15) through the compressor(16) and the fluid becomes a super critical state on passing the compressor(16). When the fluid of super critical state is injected into the barrel(11) and milled with mixing with the high molecular material by extrusion screw(14), the high molecular material which is the super critical fluid and with which carbon dioxide is saturated is made.

When the high molecular material with which carbon dioxide is saturated is injected into the extruder mold(17), the extruder mold(17) supplies the high molecular material into the pressure container(24) in which the saturation pressure as same as said reservoir tank(15) is maintained by a pressure controller(25). And then after passing a roller(21) having a constant temperature, the high molecular material is supplied to the second pressure container(20) having low pressure and expands with bubbles generated in the high molecular material. The high molecular material passes a heater(22) through a refrigerating roller(23) so as to maintain foaming state of the high molecular material foamed, and then extrusion wares in which microcellular foaming is done as such are made.

As shown in figure 2, the view of the foregoing microcellular injection molding apparatus, in the microcellular injection molding apparatus the super critical fluid carbon dioxide stored in a pressure container(33) is injected into a injection barrel(30) through a valve(33') and mixed with the high molecular material supplied from the hopper(32) by an injection screw(31). Carbon dioxide(CO_2) mixed with the high molecular material is made smaller through a mixer(34) and diffused into the high molecular material in the diffusion apparatus(36), and then high molecular material saturated with carbon dioxide(CO_2) of single phase is obtained. By heating rapidly the high molecular material by using a heater(35) bubbles are generated inside the high molecular material. at this time, it is well known that high pressure should be maintained so that bubbles generated in the injection barrel(30) can't grow.

When the melted high molecular material in which bubbles are generated is injected into a cavity(38') of a mold(38) and condensed, injection wares required can be obtained. Of course, the inside of said cavity(38') should be maintained on constant pressure so that bubbles don't grow during the filling process. This problem can be

solved by using high pressure gas of a pressure container(37). Namely during the filling process by allowing the high pressure into the cavity(38') with opening the valve of the pressure container(37) the growth of bubbles can be restrained.

But, the foregoing microcellular foaming apparatus configured as so has the problem that it's use is impossible in the injection process where the super critical fluid should be supplied intermittently at the necessary moment for the injection of the super critical fluid can't be controlled accurately.

While it is of no regards that gas be supplied continuously in the reservoir tank(15) and the compressor(16) which are the elements of gas supply apparatus in the microcellular extrusion molding apparatus for the extrusion molding performs by continuous process, but in the case of microcellular injection molding apparatus it is necessary to control the supply of the super critical fluid for the molding process is performed intermittently.

Namely, in the super critical injection molding apparatus an intermittent molding is performed, as the high molecular material saturated with the super critical fluid should step a refrigerating process after being extruded into the cavity(38') of the mold(38) and filling it. Therefore, it is necessary to coincide the supply timing of the super critical fluid according to the processing of the injection molding apparatus in order to mill with mixing the high molecular material supplied through hopper(32) and the super critical fluid injected through the pressure container(33).

The invention is for solving the said problem of the foregoing technology. the object of the invention is to provide a microcellular foaming gas supply apparatus, which enables a continuous molding process, which can be used for mass production, which ensures the curtailment of the energy cost and the stability for the continuous molding process by controlling the supply of the super critical fluid into the barrel at the time required in the molding process using a microcellular foaming apparatus.

[DETAILED DESCRIPTION OF THE INVENTION]

To achieve the said object, the invention is characterized as having a injection screw located in a barrel and injecting an application material, a hopper supplying the high molecular material into said barrel, a heater located around said barrel and melting the high molecular material in the barrel, a molding apparatus controller part controlling the movement of said injection screw, and an microcellular molding apparatus composed of a gas supply means which supplies the super critical fluid into said barrel and makes micro bubbles generated in the application material; said gas supply means composed of a reservoir tank storing fluid, a compressor compressing the fluid supplied from said reservoir tank, a pressure tank storing temporarily the fluid compressed in said compressor, the first valve located in a pipe between said compressor and the pressure tank, a high pressure tank where the fluid supplied from said pressure tank is stored temporarily and the fluid stored by heating is transformed into the super critical fluid, the second valve located in a pipe between said pressure tank and the high pressure tank, a heater located around said high pressure tank, a heater controller controlling said heater with sensing the temperature of said high pressure tank, the third

valve located in a pipe supplying the super critical fluid of said high pressure tank into said barrel, and a controller part controlling the movement of each valve and said compressor with sensing the signals of said molding apparatus controller part and the pressure of each tank.

Generally, in order to manufacture the molding wares having microcellular bubbles with the microcellular foaming apparatus, a constant amount of fluid should be supplied into the barrel of the molding apparatus on request of the timing of the molding apparatus, the various kinds of the fluid supplied into the barrel of the molding apparatus are used according to the kind of high molecular material. The following table 1 shows a critical state of the various kinds of fluid used for the super critical fluid.

In addition, figure 3 shows a pressure-specific diagram and a temperature-specific entropy diagram of the carbon dioxide used for the super critical fluid.

[TABLE 1]

SUPER CRITICAL FLUID	CRITICAL TEMPERATURE(℃)	CRITICAL PRESSURE(psi)
carbon dioxide(CO_2)	31.1	1071.3
methane(C_2H_8)	32.3	708.3
ethylene(C_2H_4)	9.3	742.1
nitrogen(N_2)	-147.0	492.3
freon-12	115.7	581.9
oxygen(O_2)	-118.6	736.2
ammonia(NH_3)	132.5	1635.7
hydro oxygen(H_2O)	374.2	3208.1

With reference to table 1, as each of the super critical fluid supplied into the barrel of the molding apparatus has the various critical temperature and the critical pressure, the gas supply apparatus manufacturing super critical fluid should be able to control the critical temperature and the critical pressure of the fluid. In addition, as the solving rate, the rate of the super critical fluid injected into high molecular material varies according to the kind of the high molecular material, the supply amount of the super critical fluid injected into the barrel of the molding apparatus should be controlled according to the kind of high molecular material.

The following describes the preferred embodiment of the invention with references to the figures attached.

The super critical foam molding gas supply apparatus of the invention, as shown in figure 4, is used for the microcellular foaming apparatus composed of an injection screw(51) injecting an application material located in a barrel(50), a hopper(53) supplying high molecular material into said barrel(50), a heater located around said barrel(50) and melting the high molecular material in the barrel(50), a molding apparatus controller part(61) controlling the movement of said injection screw(51), and a gas supply means supplying the super critical fluid into said barrel(50) and generating extremely micro bubbles in the application material.

The said gas supply means, the essential part of the invention, is composed of a reservoir tank(54) storing fluid, a compressor(55) compressing the fluid supplied from said reservoir tank(54), a pressure tank(56) storing temporarily the fluid compressed from said compressor(55), the first valve(60a) located in a pipe between said compressor(55) and the pressure tank(56), the high pressure tank(57) where the fluid supplied from said pressure tank(56) is temporarily stored and the stored fluid is transformed into the super critical fluid by heating, the second valve(60b) located in a pipe between said pressure tank(56) and the high pressure tank(57), a heater(58) located around said high pressure tank(57), a heater controller(59) controlling said heater(58) with sensing the temperature of said high pressure tank(57), the third valve(60c) located in a supply pipe supplying the super critical fluid of said high pressure tank(57) into said barrel(50), the controller part(62) controlling the movement of each valve(60a,60b,60c) and said compressor(55) with sensing the signals of said molding apparatus controller part(61) and the pressure of each tank(56,57), and the fourth valve(60d) located between the said third valve(60c) and a gas injection entrance and banning the countercurrent from the barrel(50) when the pressure of the super critical fluid in the said high pressure tank(57) is lower than the pressure in the barrel(50).

The first pressure sensor(56') for sensing the pressure is installed in said pressure tank(56), the second pressure sensor(57') and the temperature sensor(57") for sensing temperature is installed in said high pressure tank(57), and the third pressure sensor(63) for sensing the pressure of the high molecular material melted in the barrel(50) is installed around the gas injection entrance of the barrel(50). The said controller part(62) is composed of a controller A controlling said compressor(55) and the first valve(60a) according to the signals of the first pressure sensor(56'), a controller B controlling the second valve(60b) according to the signals of the second pressure sensor(57'), a controller C controlling the third valve(60c) and the fourth valve(60d) according to the signals of said molding apparatus controller part(61), and a controller D controlling said the fourth valve(60d) with comparing the signals of the second pressure sensor(57') and the signals of the third pressure sensor(63).

The microcellular foaming gas supply apparatus of the invention configured as said enables the mass production process by supplying the microcellular fluid on the request of the molding apparatus as like the injection molding and the extrusion molding.

When the injection screw(51) is moved leftward on receiving the signals of the molding apparatus controller part(61), the high molecular material(70) of the hopper(53) is supplied into the barrel(50) of the molding apparatus. The high molecular material supplied into the barrel(50) is melted by the rotating of the injection screw(51) and heating by the heater(52), and is milled with mixing with the carbon dioxide, the super critical fluid supplied from the gas supply means through the gas injection entrance of the barrel(50). At this time, as the carbon dioxide injected into the barrel(50) through the gas injection entrance should be made on super critical state, the carbon dioxide stored in the reservoir tank(54) is transformed into super critical fluid in the gas supply means.

After the carbon dioxide of the reservoir tank(54) is inflowed into the compressor(55) and compressed, the carbon dioxide is stored in the pressure tank(56) through the first valve(60a). At this time, the first valve(60a) is opened or closed according to the pressure of the pressure tank(56). Namely, the controller A controls the movement of the first valve(60a) and the compressor(55) with receiving the signals of the first pressure sensor(56') sensing the pressure of the pressure tank(56).

The carbon dioxide stored in the pressure tank(56) is inflowed into the high pressure tank(57) through the second valve(60b) which is opened or closed by the controller B. Namely, the second pressure sensor(57') senses the pressure of the high pressure tank(57) and sends the signals to the controller B, and the controller B controls the opening or closing of the second valve(60b) and supplies the compressed carbon dioxide stored in the pressure tank(56) to the high pressure tank(57).

The high pressure tank(57) transforms the carbon dioxide supplied from the pressure tank(56) into the super critical fluid, Namely, the heater controller(59) sensing the temperature of the carbon dioxide by the temperature sensor(57") makes the carbon dioxide in the high pressure tank(57) on super critical state by controlling the heater(58) and heating the carbon dioxide.

The controller C receiving the signals from the molding apparatus controller part(61) opens or closes the third valve(60c) and the fourth valve(60d) of the supply pipe and injects the carbon dioxide which is stored in the high pressure tank(57) and on super critical fluid state into the barrel(50) through the gas injection entrance of the barrel(50), and on finishing of the injection of the super critical fluid, the third valve(60c) and the fourth valve(60d) is closed automatically and stops the supply of the super critical fluid.

At this time, the third pressure sensor(63) located around the gas injection entrance senses the pressure of the melted high molecular material around the gas injection entrance and sends it to controller D, and the controller D compares the pressure of the high pressure tank(57) sent by the second pressure sensor(57') and the pressure around the gas injection entrance. and if the pressure of the high pressure tank(57) is lower than that of the other, then it closes the fourth valve(60d) so that the high molecular material mixed with the carbon dioxide in the barrel(50) does not counter flow toward the high pressure tank(57).

[THE EFFECTIVENESS OF THE INVENTION]

As described above, the microcellular foaming gas injection apparatus of the invention provides advantageously the microcellular foaming by supplying the proper amount of the super critical fluid at proper time on the request of the molding apparatus.

As the compressor, the pressure tank and the high pressure tank transforming fluid into super critical fluid are configured in a lump, continuous molding process is possible, and they can be utilized in mass production process as like the injection molding and extrusion molding.

As the operating of the compressor is stopped and the supply of the compressed gas is banned if the compressed gas supplied from the compressor is beyond the defined scale of the pressure of the pressure tank, the pressure tank always maintains the constant capacity and supplies stably the compressed gas into the high pressure tank, curtails the energy cost and extends the life of the compressor by preventing unnecessary operating of the compressor.

The supply of the super critical fluid stored in the high pressure tank into the molding apparatus at proper time in connections with the operating of the molding process is possible, and the countercurrent from the molding apparatus toward the high pressure tank is prevented, so the stability for the continuous molding process can be obtained.

As the fourth valve is closed when the pressure of the molding apparatus is higher than that of the super critical fluid injected, the blocking of the supply pipe by the high molecular material counterflowed from the molding apparatus can be prevented. So the continuous molding process is performed.

[CLAIMS]

1 A microcellular foaming gas supply apparatus characterized as composed of a injection screw located in a barrel and injecting an application material, a hopper supplying high molecular material into the barrel, a heater located around the barrel and melting the high molecular material in the barrel, a molding apparatus controller part controlling the movement of said injection screw, and an microcellular foam molding apparatus composed of a gas supply means supplying a super critical fluid into said barrel and generating extremely micro bubbles in the application material; said gas supply means having a reservoir tank storing the fluid, a compressor compressing the fluid supplied from said reservoir tank, a pressure tank storing temporarily the fluid compressed from said compressor, the first valve located in a pipe between said compressor and the pressure tank, a high pressure tank storing temporarily the fluid supplied from said pressure tank and transforming the fluid stored by heating into an super critical fluid, the second valve located in a pipe between said pressure tank and the high pressure tank, a heater located around said high pressure tank, a heater controller controlling said heater with sensing the temperature of said high pressure tank, the third valve located in a supply pipe supplying the super critical fluid of said high pressure tank into said barrel, and a controller part controlling the movement of each valve and said compressor with sensing the signals of said molding apparatus controller part and the pressure of each tank.

2 The microcellular foaming gas supply apparatus of Claim 1 further characterized as having the fourth valve banning the countercurrent from the barrel when the pressure of the super critical fluid in said high pressure tank is lower than that in the barrel, the said fourth valve located between the said third valve and a gas injection entrance.

3 The microcellular foaming gas supply apparatus of Claim 1 further characterized as having the first pressure sensor in said pressure tank, the second

pressure tank and a temperature sensor sensing a temperature in said high pressure tank, and the third pressure sensor around the gas injection entrance of said barrel for sensing the pressure in the barrel.

4 The microcellular foaming gas supply apparatus of Claim 1, 2, or 3 further characterized as having said controller part composed of a controller A controlling said compressor and the first valve according to the signals of the said first sensor, a controller B controlling the said second valve according to the signals of the said second pressure sensor, a controller C controlling the third valve and the fourth valve according to the signals of said molding apparatus controller part, and a controller D controlling the said fourth valve with comparing the signals of the said second pressure sensor and the signals of the third pressure sensor.

[DRAWINGS]
FIGURE 1

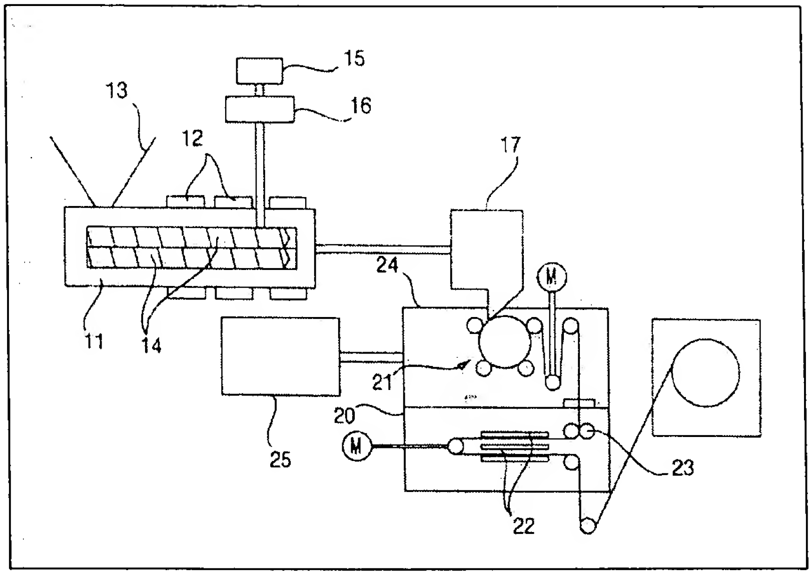


FIGURE 2

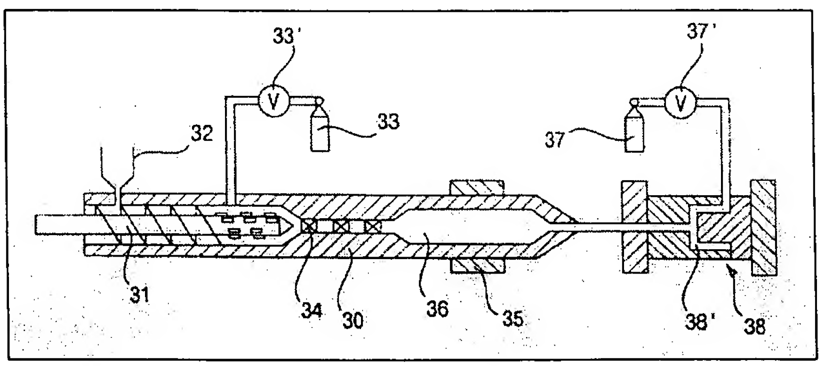


FIGURE 3a

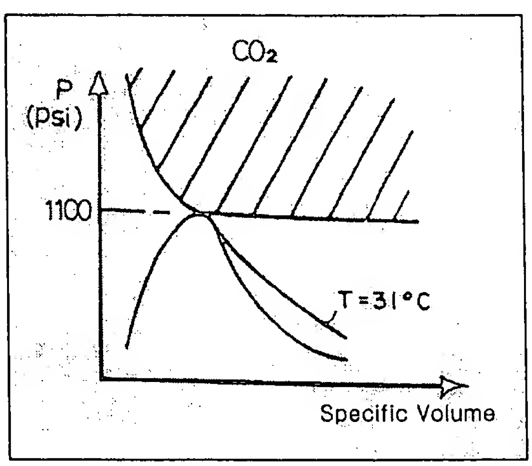


FIGURE 3b

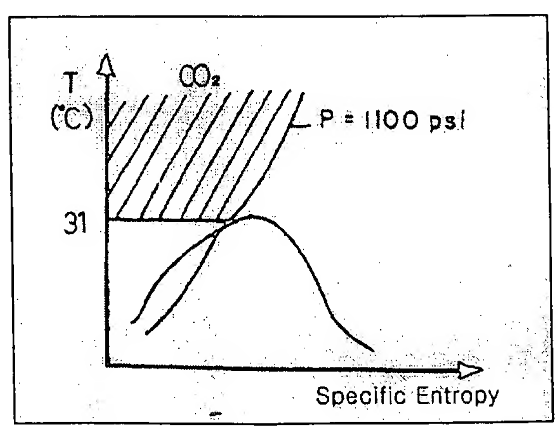
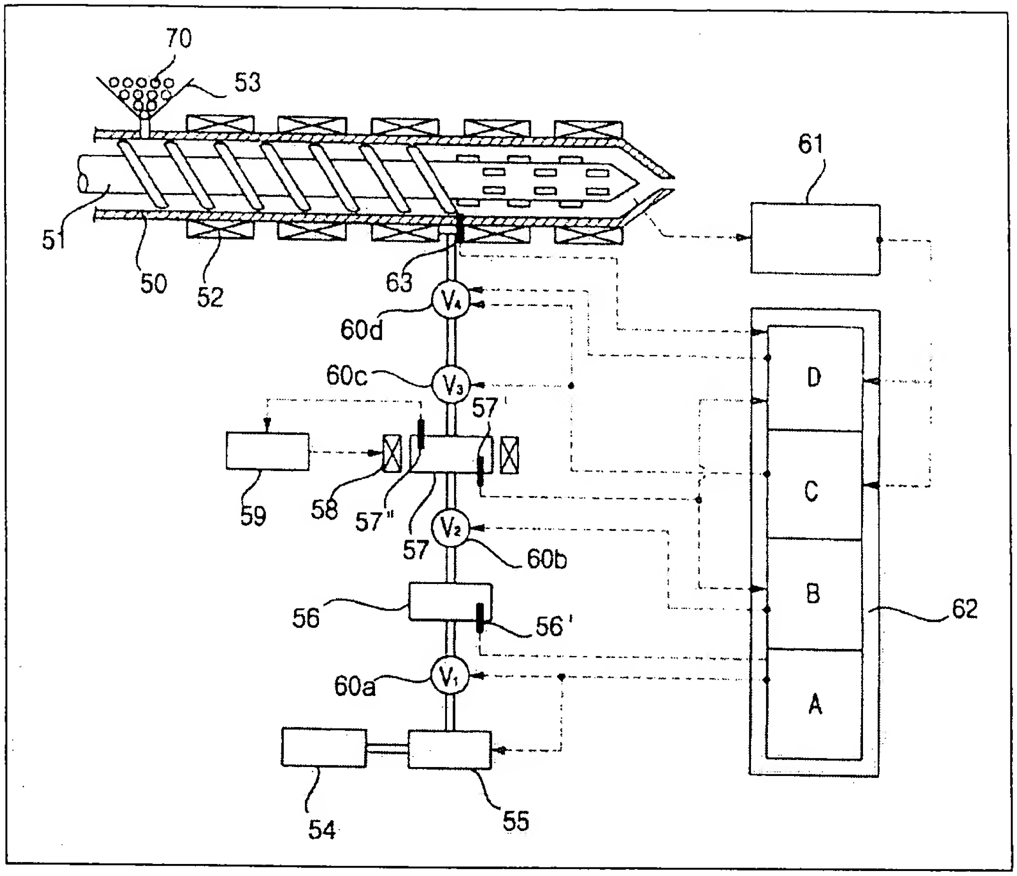


FIGURE 4



70
53
61
51
50
52
63
V4
60d
60c
V3
D
57'
C
59
58
57"
57
V2
60b
B
56
56'
62
60a
V1
A
54
55